Frequency Reference Choices for Synchronisation in 5G Front-Haul Applications

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1 Topics

- Overview of front-haul networks
- Network requirements
- Reference clock considerations
- Options
- Summary

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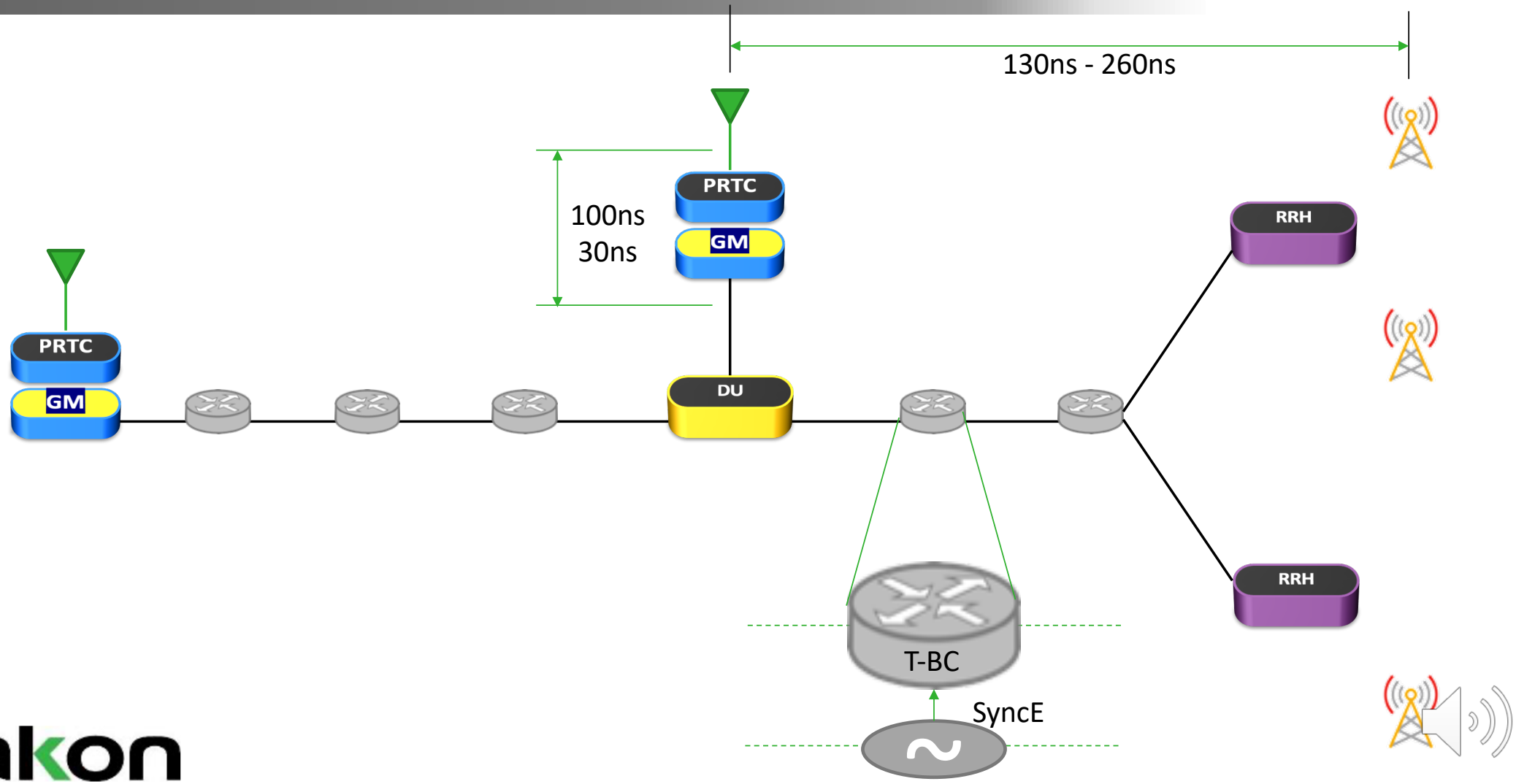
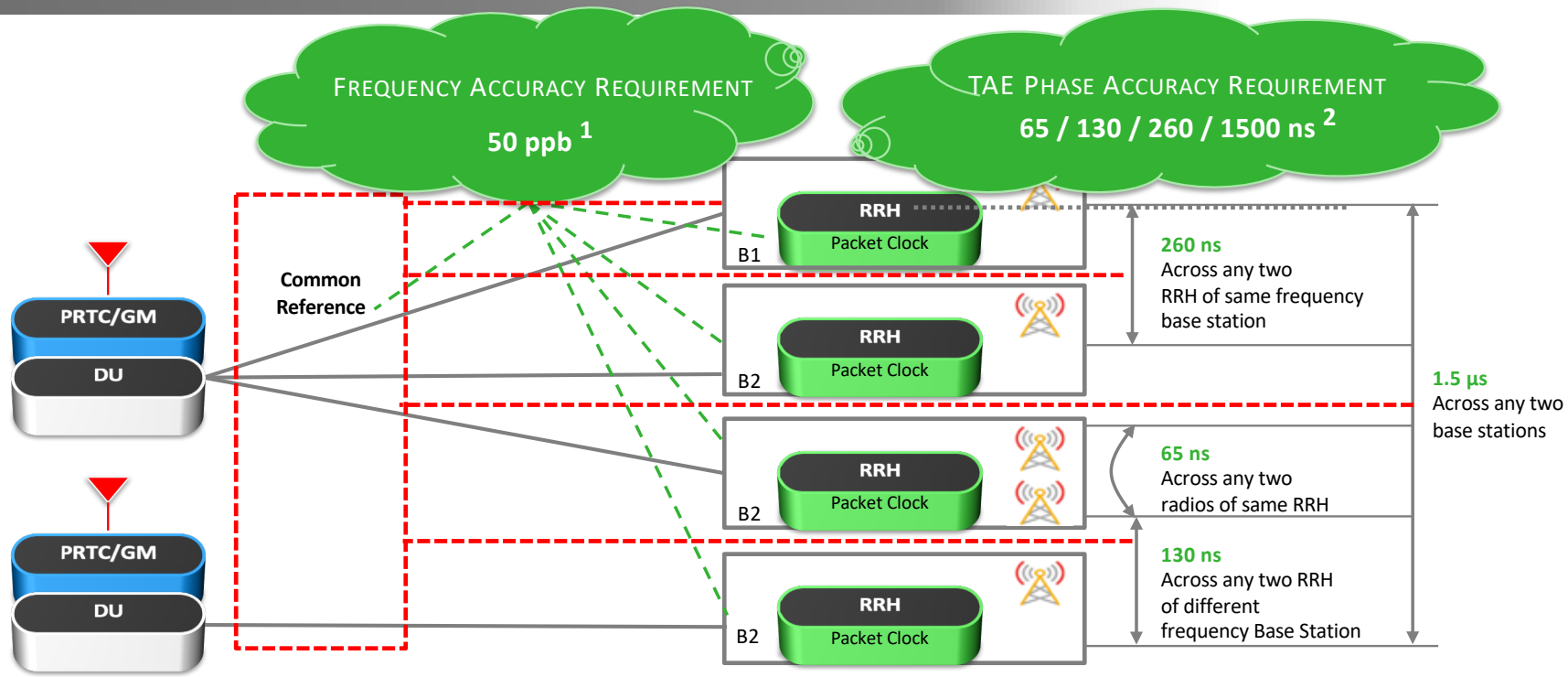
2 ORAN – C2



3 Frequency & Time Alignment Error Requirements



1 50 ppb with respect to a common frequency reference on all stations

2

Category	TAE	Applications Details
A+	65 ns	MIMO or TX diversity transmissions, at each carrier frequency
A	130 ns	Intra-band contiguous carrier aggregation, with or without MIMO or TX diversity 260 ns
B	260 ns	A & Inter-band carrier aggregation, with or without MIMO or TX diversity
C	1500 ns	3GPP LTE TDD

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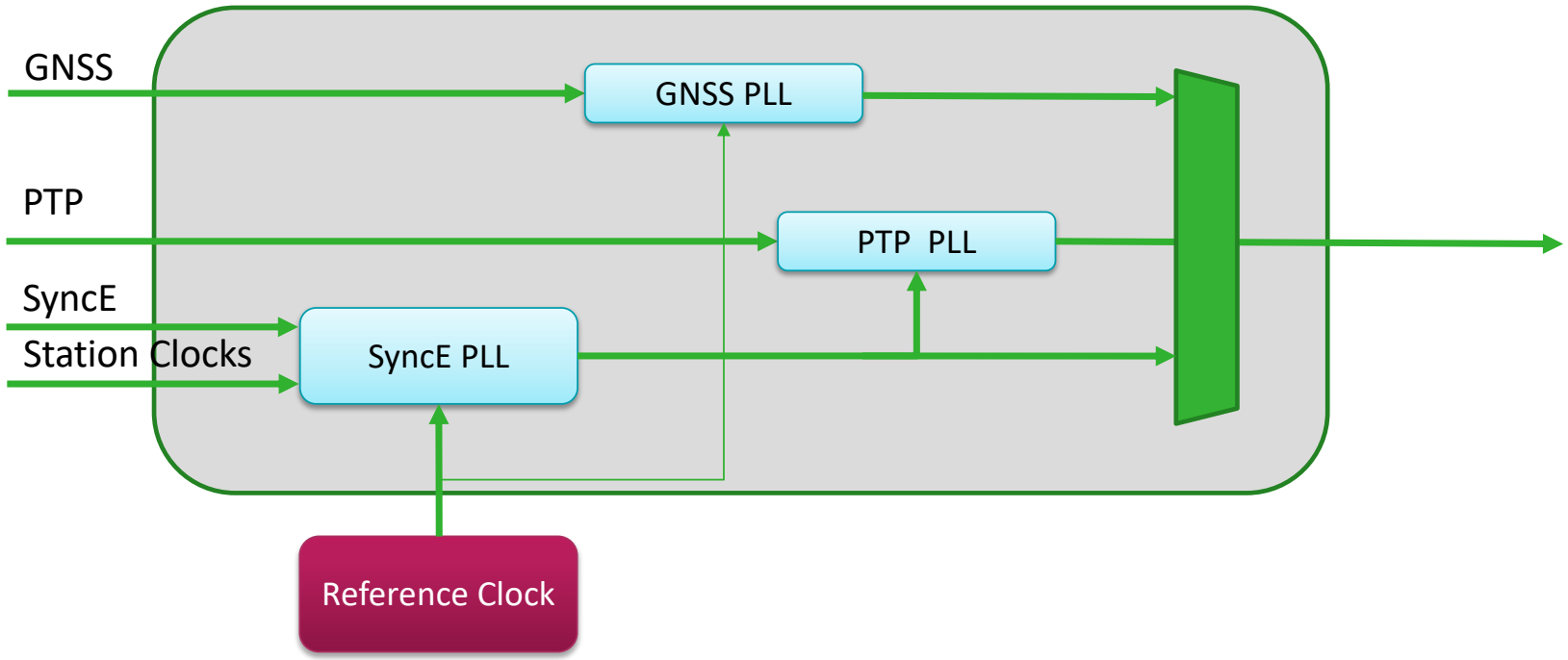
Common Clock architectures

- Combines GNSS, PTP, SyncE and Station Clocks together



5 Details of Scenarios

- **G.8273.2 does not mandate SyncE**
  - No SyncE case need stronger oscillator to support similar
- **There is possibility of Partial Timing support - G.8273.3**
  - Partial timing support uses lower bandwidth and therefore stronger oscillator
- **There is possibility of Assisted – Partial Timing support (GNSS into the system)**
  - 1Hz input needs lower bandwidth and therefore needs stronger oscillator
- **End system requirement differs from a simple T-TSC**
  - Eg of RRH needs 50ppb in 1ms frequency accuracy and <130ns phase error to support MIMO
- **The combination of Synchronization sources are unknown**
- **Support for Synchronization from Broadband Network is unknown**
- **Holdover requirements are unknown**

6 Comparison of T-BC classes

Sl No	Parameter	T-BC - A	T-BC - B	T-BC - C	T-BC - D	Remarks
	Max Absolute Time Error	100	70	30	FFS	
	Max Absolute Time Error (Low pass filtered)				5	Only for Class D
	Constant Time Error	50	20	10	FFS	
	Dynamic Time Error MTIE	40	40	10	FFS	
	Dynamic Time Error MTIE with Temp	40	40	10	5	
	Dynamic Time Error TDEV	4	4	2	FFS	

All units in nano seconds

FFS – For Further Study
NS – Not specified

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Background

- **Frequency Stability Vs Temperature**
  - Defines the operating range
- **Frequency Slope**
  - Sensitivity to Temperature
- **Airflow sensitivity**
  - Varying airflow
- **Shock & vibration**

Reference Clock options

KEY PARAMETERS	TCXOs	Advanced TCXOs	Hybrid TCXOs	Mini OCXOs	Stratum 3E OCXOs	SMART OCXOs
Package (mm)	5.0 x 3.2, 7x5	7x5	7x5	9x7	14x9	25x22
Operating Range	(-40 to 85°C)	(-40 to 85°C)	(-40 to 105°C)	(-40 to 105°C)	(-40 to 85°C)	(-40 to 85°C)
Stability	±50 ppb	±50 ppb	±20 ppb	±10 ppb	±5 ppb	±0.5 ppb
Frequency Slope	15 ppb/°C	5 ppb/°C	0.5 ppb/°C	0.1 ppb/°C	0.05 ppb/°C	0.01 ppb/°C
Ageing	10ppb/day	10ppb/day	0.5ppb/day	0.5ppb/day	0.3ppb/day	0.2ppb/day
Holdover (1us for 10degC)	-	-	30min	1 hour	2 hours	4-24* hours

*With ageing compensation

HTCXO – Replacing traditional TCXOs

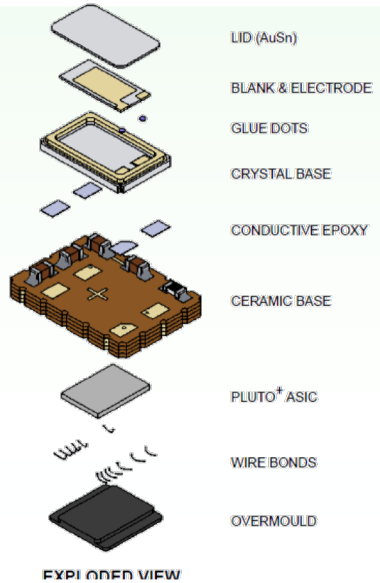
TCXO ASIC does real-time temperature reading, and use in-built polynomial to compensate for frequency variation at different temperatures

Stability : 50ppb – 300ppb ; Slope : 5-10ppb/degC

HTCXO ASIC performs temperature compensation same as a TCXO manages heated element to keep the temperature of the resonator constant.

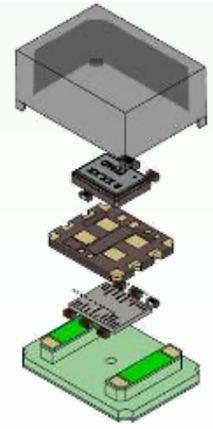
Stability : 20ppb – 50ppb ; Slope : 0.1-1ppb/degC

7 x 5 mm TCXO



HTCXO enables slope, frequency stability, and Phase noise that is a factor of x10 better than any TCXO, TCMO. Without the need to compromising product size, complexity or cost.

7 x 5 mm & 5 x 3 mm HTCXO



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Summary

- Synchronization performance of front-haul elements are challenging
- Generic designs with careful selection can address number of applications
- There is a variety of frequency reference solutions available to address this challenging problem

Thank you